Superporous agarose scaffolds for encapsulation of adult human islets and human stem-cell-derived beta cells for intravascular bioartificial pancreas applications.

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Public Summary:
New approaches for the Type 1 diabetes are based on implanting insulin-producing stem cells. We are developing a device to encapsulate cells and keep them alive without immunosuppression. To ensure longevity of the device, we investigated the use of a material - superporous agarose (SPA) - that could support the cells by providing suitable mechanical support and optimal distribution of nutrients. Our work shows that SPA is a feasible scaffold for this purpose.

Scientific Abstract:
Type 1 diabetic patients with severe hypoglycemia unawareness have benefitted from cellular therapies, such as pancreas or islet transplantation; however, donor shortage and the need for immunosuppression limits widespread clinical application. We previously developed an intravascular bioartificial pancreas (iBAP) using silicon nanopore membranes (SNM) for immunoprotection. To ensure ample nutrient delivery, the iBAP will need a cell scaffold with high hydraulic permeability to provide mechanical support and maintain islet viability and function. Here, we examine the feasibility of superporous agarose (SPA) as a potential cell scaffold in the iBAP. SPA exhibits 66-fold greater hydraulic permeability than the SNM along with a short (<10 mum) diffusion distance to the nearest islet. SPA also supports short-term functionality of both encapsulated human islets and stem-cell-derived enriched beta-clusters in a convection-based system, demonstrated by high viability (>95%) and biphasic insulin responses to dynamic glucose stimulus. These findings suggest that the SPA scaffold will not limit nutrient delivery in a convection-based bioartificial pancreas and merits continued investigation.